

# DSM2 PTM, an Open Source Platform for Delta Fish Migration Behavior Research and Model Development

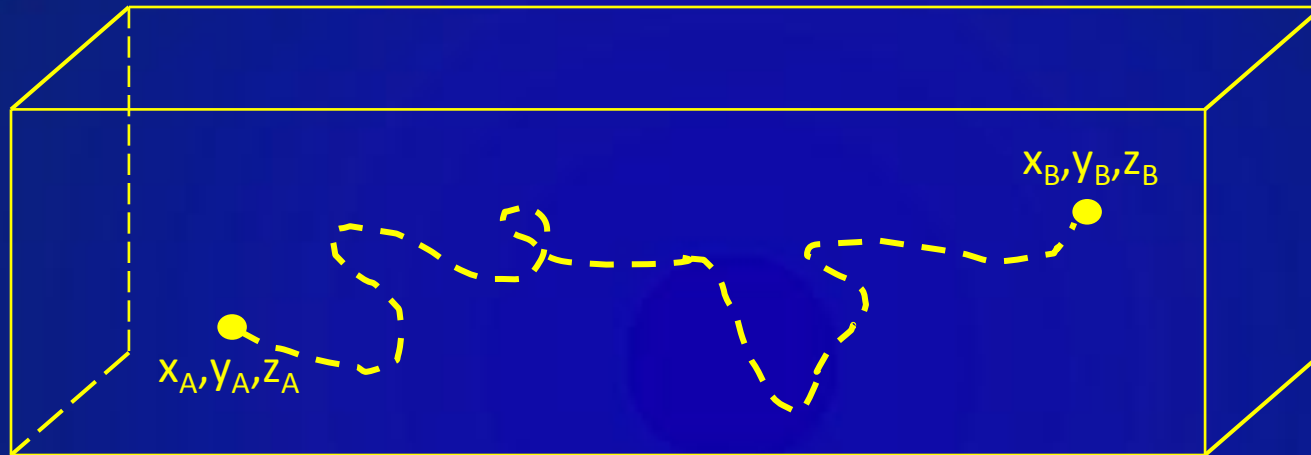
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# Goal

Develop a fish migration model to:

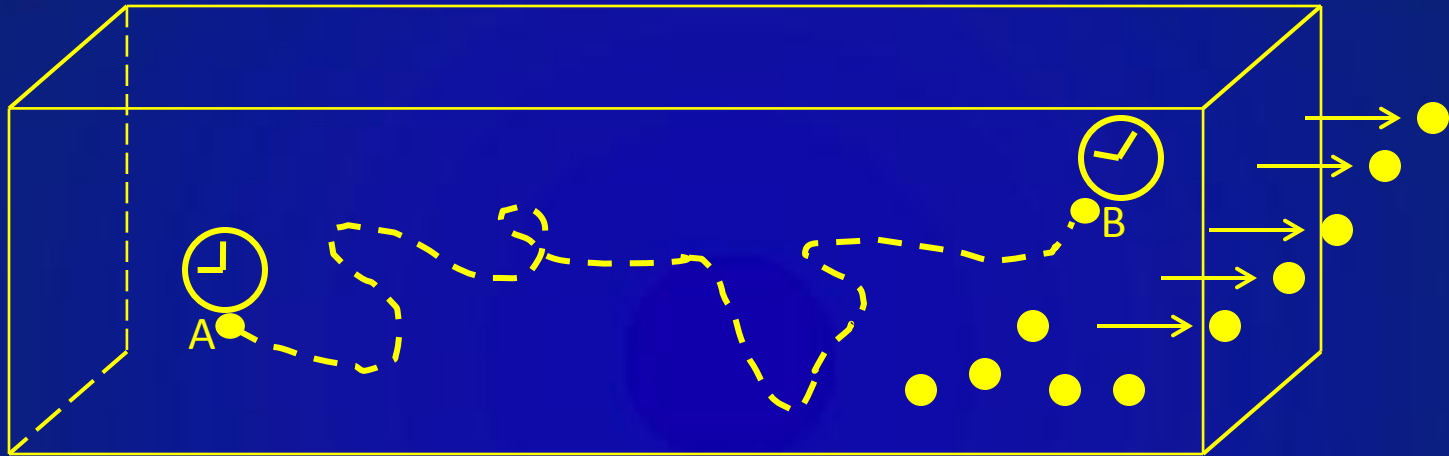
- Identify environmental factors that affect fish behaviors and survival
- Evaluate ecological impacts
- Assist management decision-making
- Guide field monitoring programs

# Current PTM Features



- Tracking particle positions in 3D space
- Time step determined by user and flow Conditions
- Built-in random walk components

# Current PTM Output



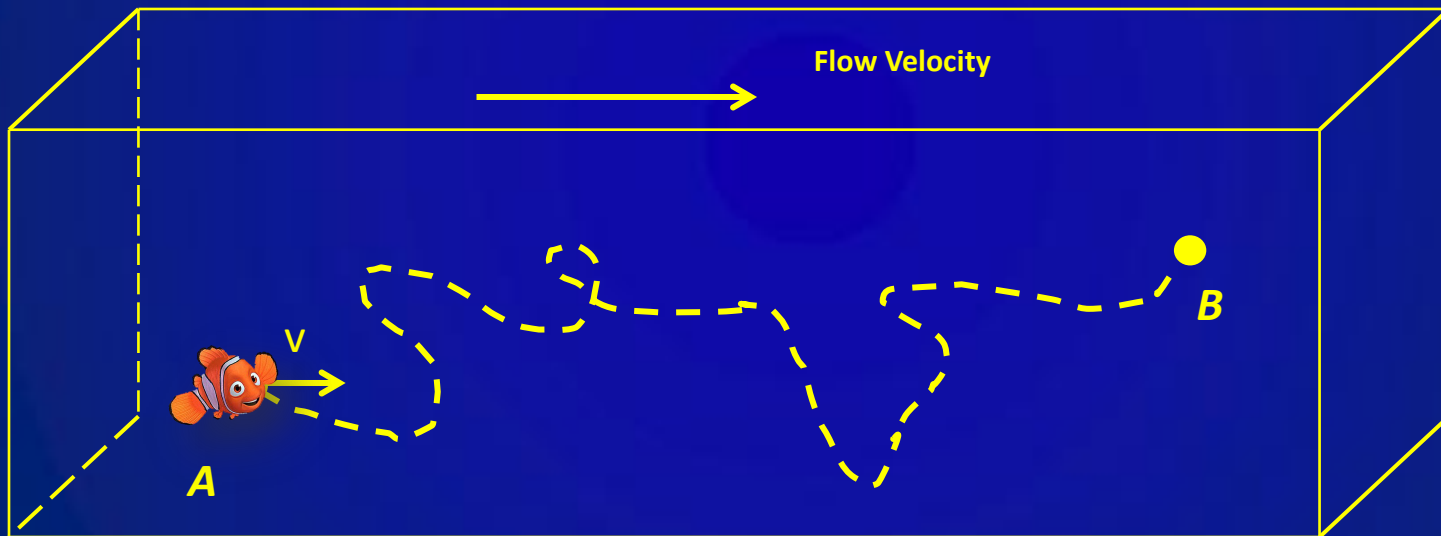
- Individual particle travel time from A to B
- Particle flux: # of particles passing specified location
- Particle concentration: # of particles in specified area

# Neutral Buoyant Particle = Fish ?

- Move passively with flow, no active swimming velocity
- Make route choice based on flow split
- Always stay alive

# Add Swimming Behavior

Fish movement velocity = flow velocity +  
constant swimming velocity ( $v$ )



# Estimate Constant Swimming Velocity

- Obtain observed fish travel time data from acoustic telemetry fish studies
- Run PTM simulations to generate simulated travel times
- Maximize likelihood function to estimate the velocity

# Obtain Observed Fish Travel Times Studies

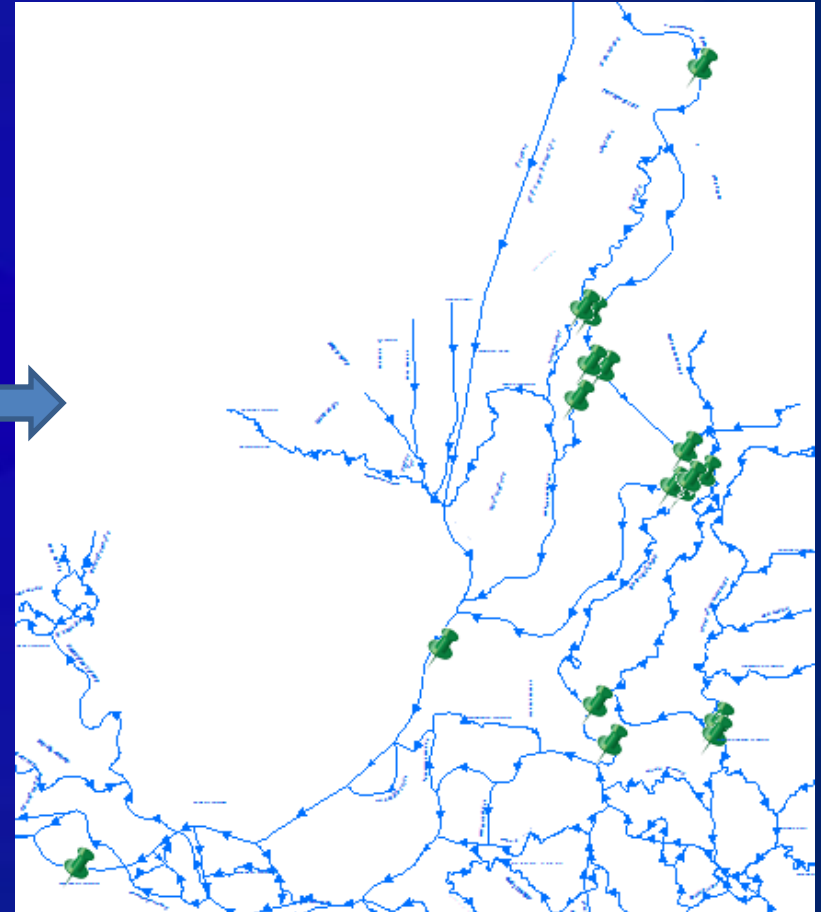
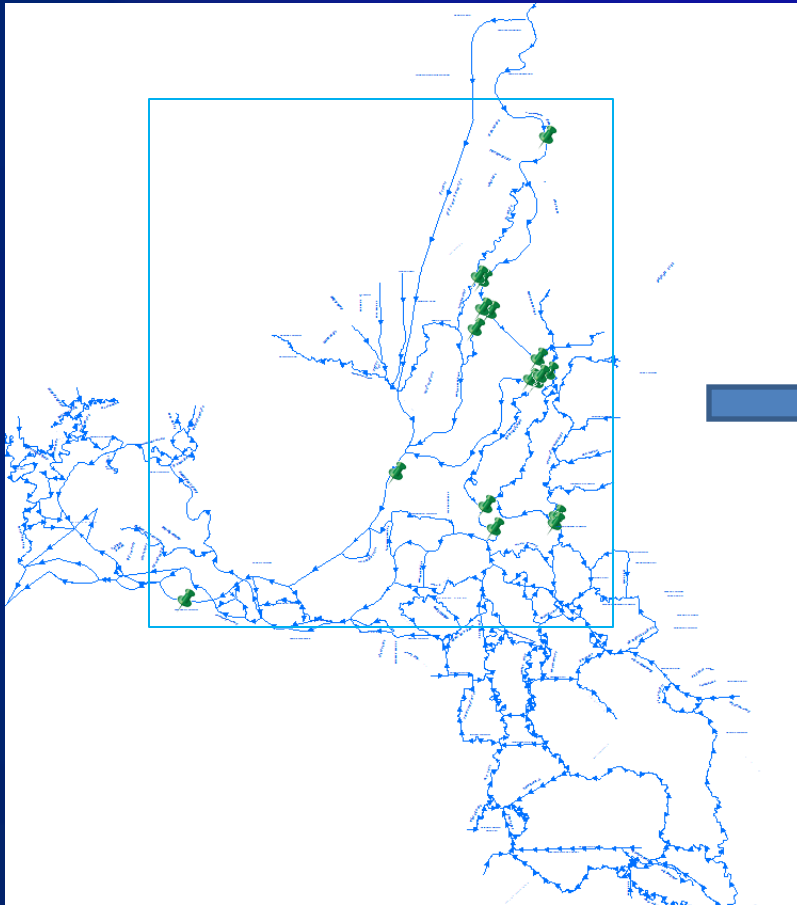
## Acoustic telemetry fish studies:

- Collected by USFWS
- Late-fall Chinook from Coleman NFH
- Tagged and released in DEC – JAN 2007-2010
- Total sample size: 1147



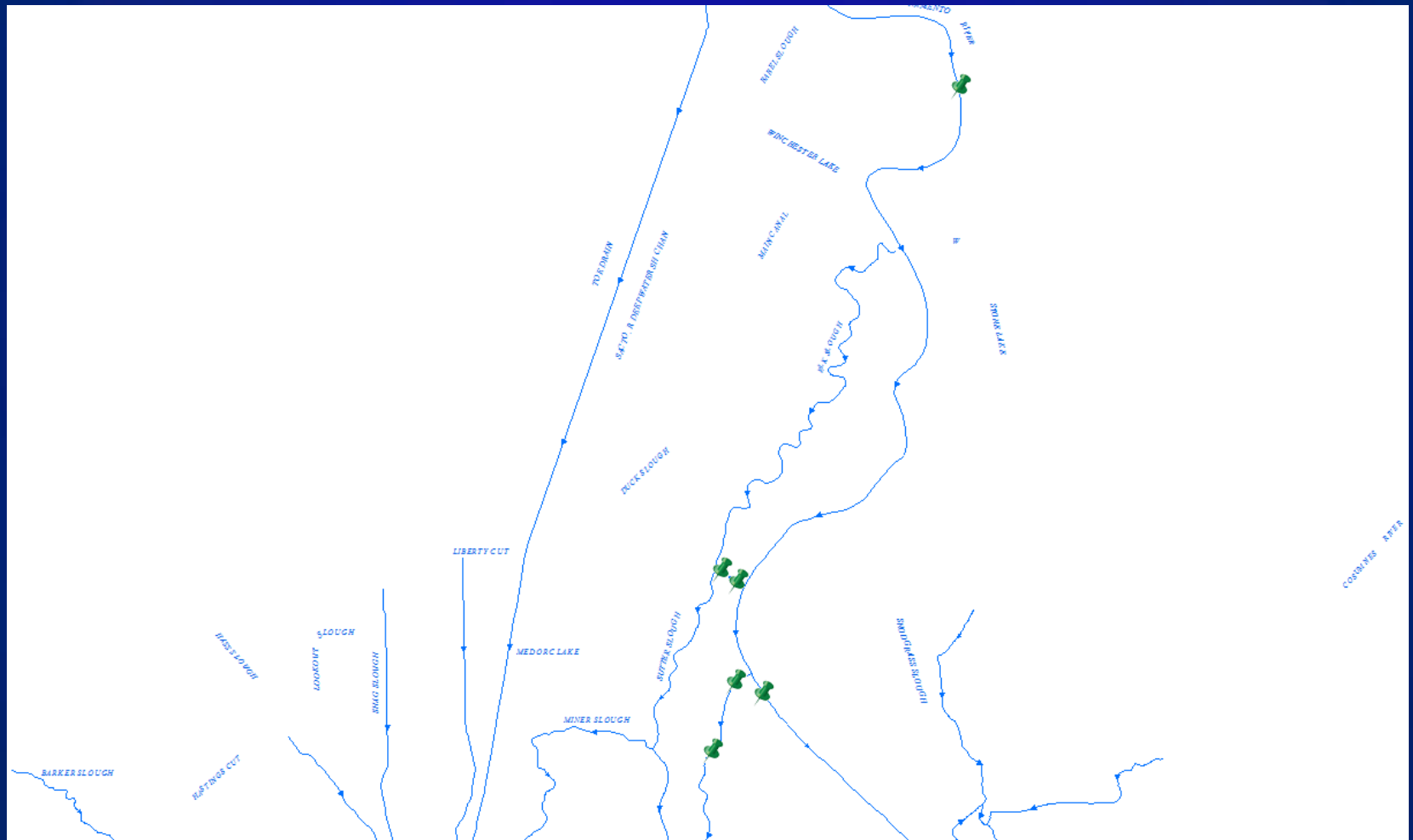
# Obtain Observed Fish Travel Times

Detection Stations

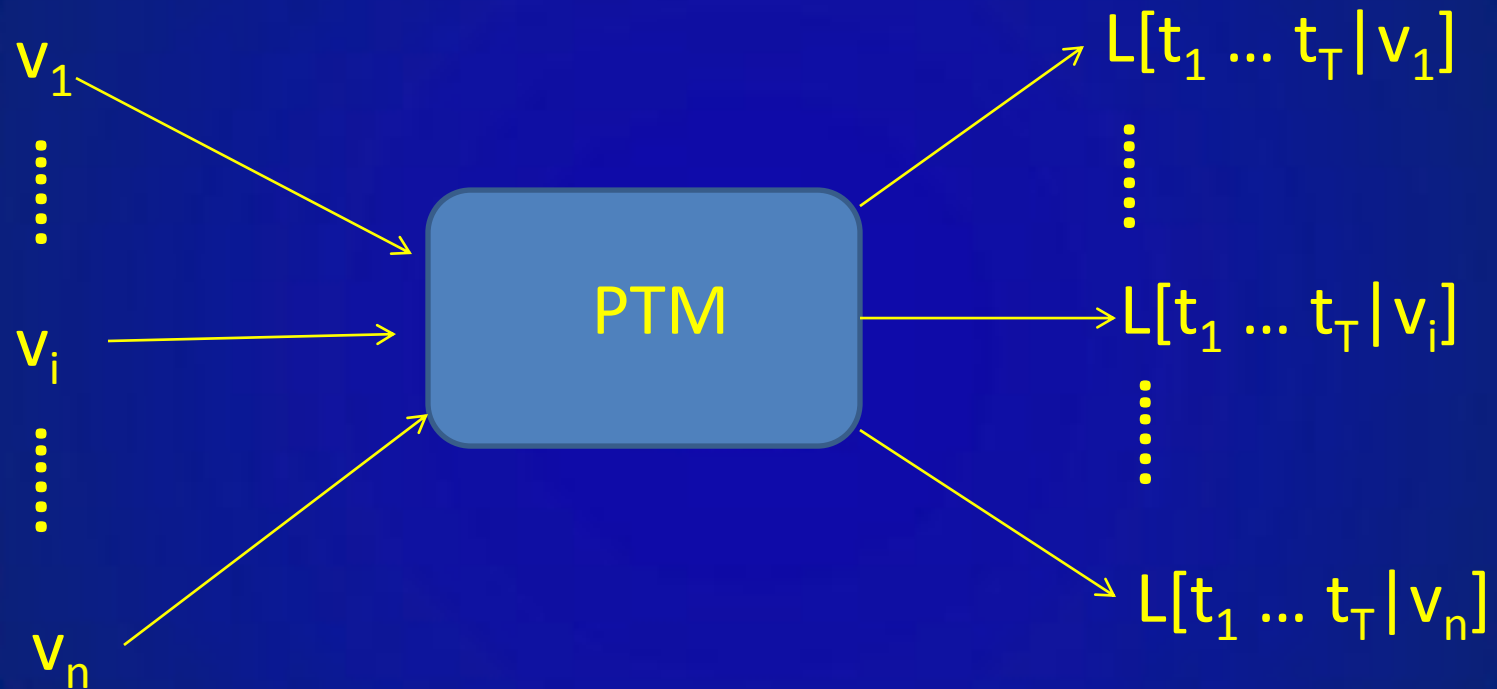


# Obtain Observed Fish Travel Times

## Detection Stations

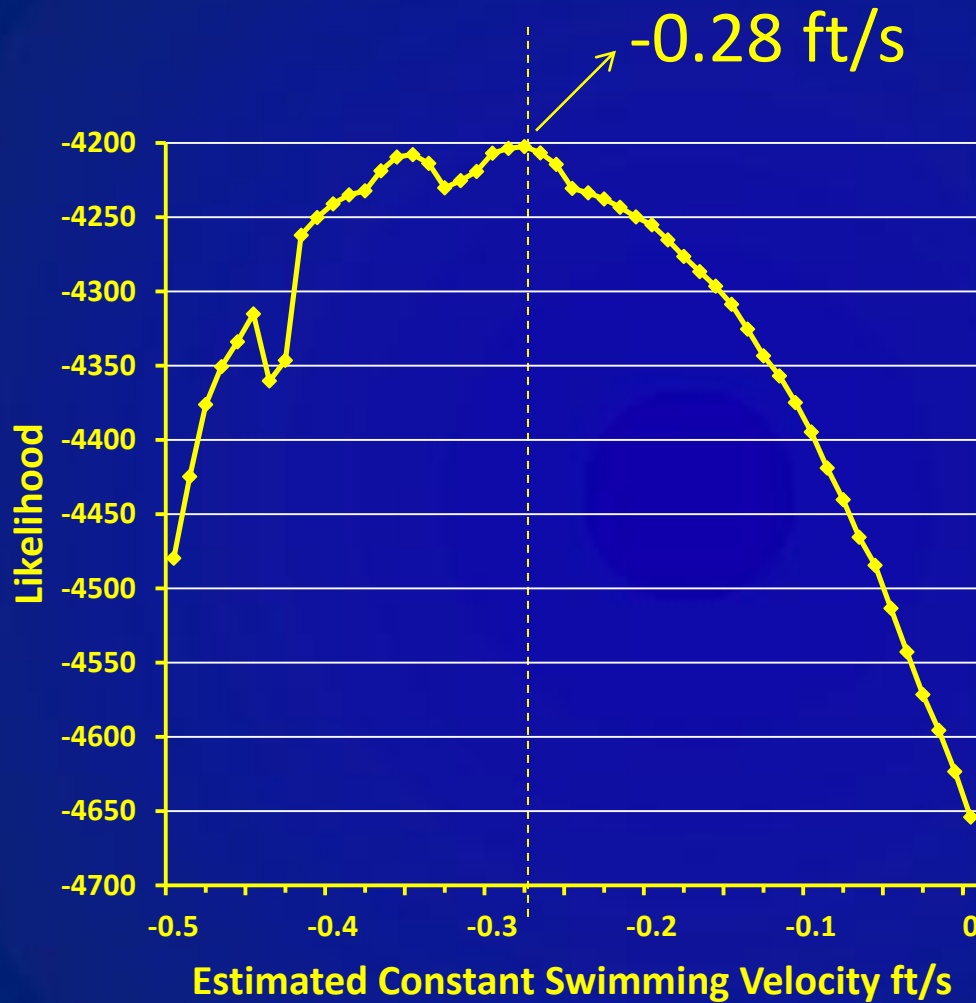


# Run PTM Simulations



Observed  $t_1 \dots t_T$

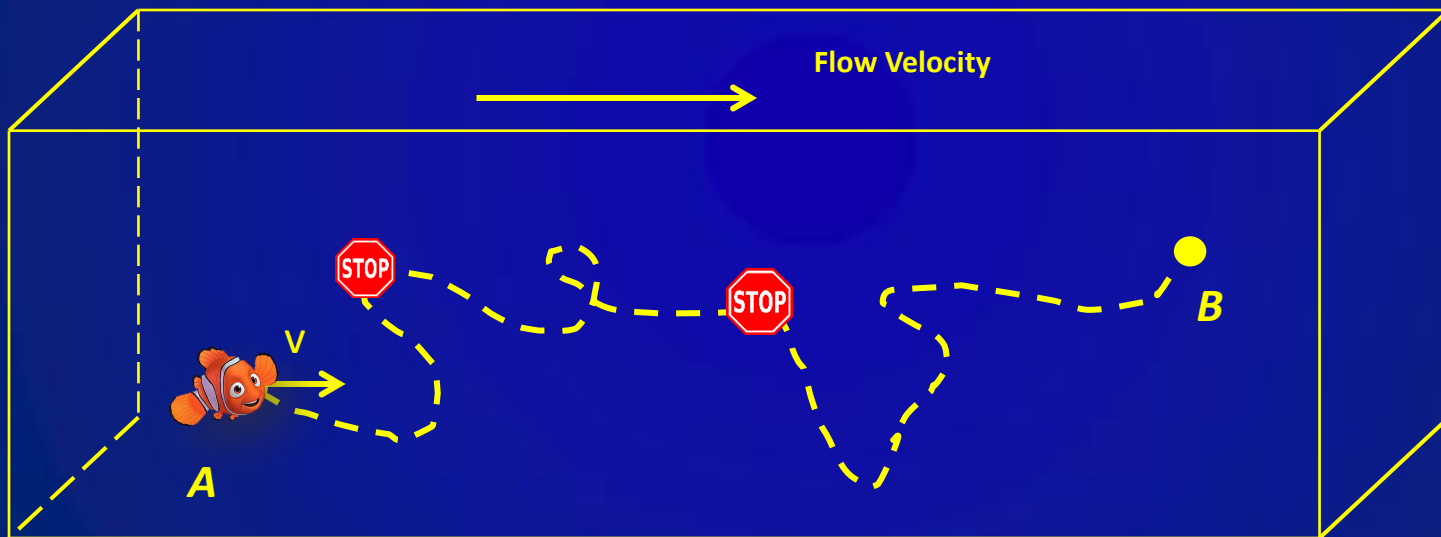
# Maximize Likelihood Function



Fish hold and move slower than flow!

# Fish Holding Behavior

Fish movement velocity = flow velocity +  
constant swimming velocity (-0.28)



Nocturnal migration, diurnal holding

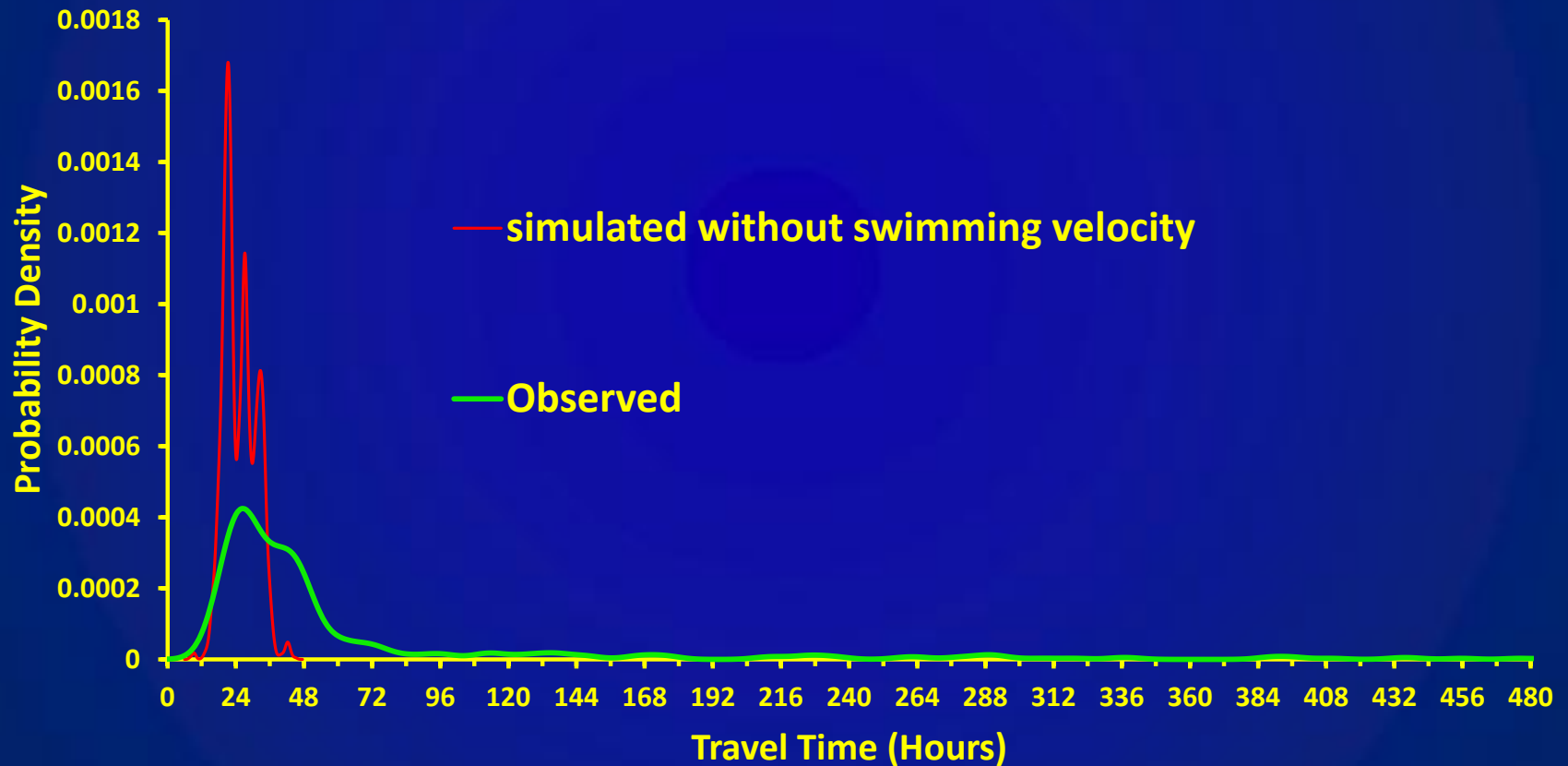


Selective tidal stream transport, holding during flood tides

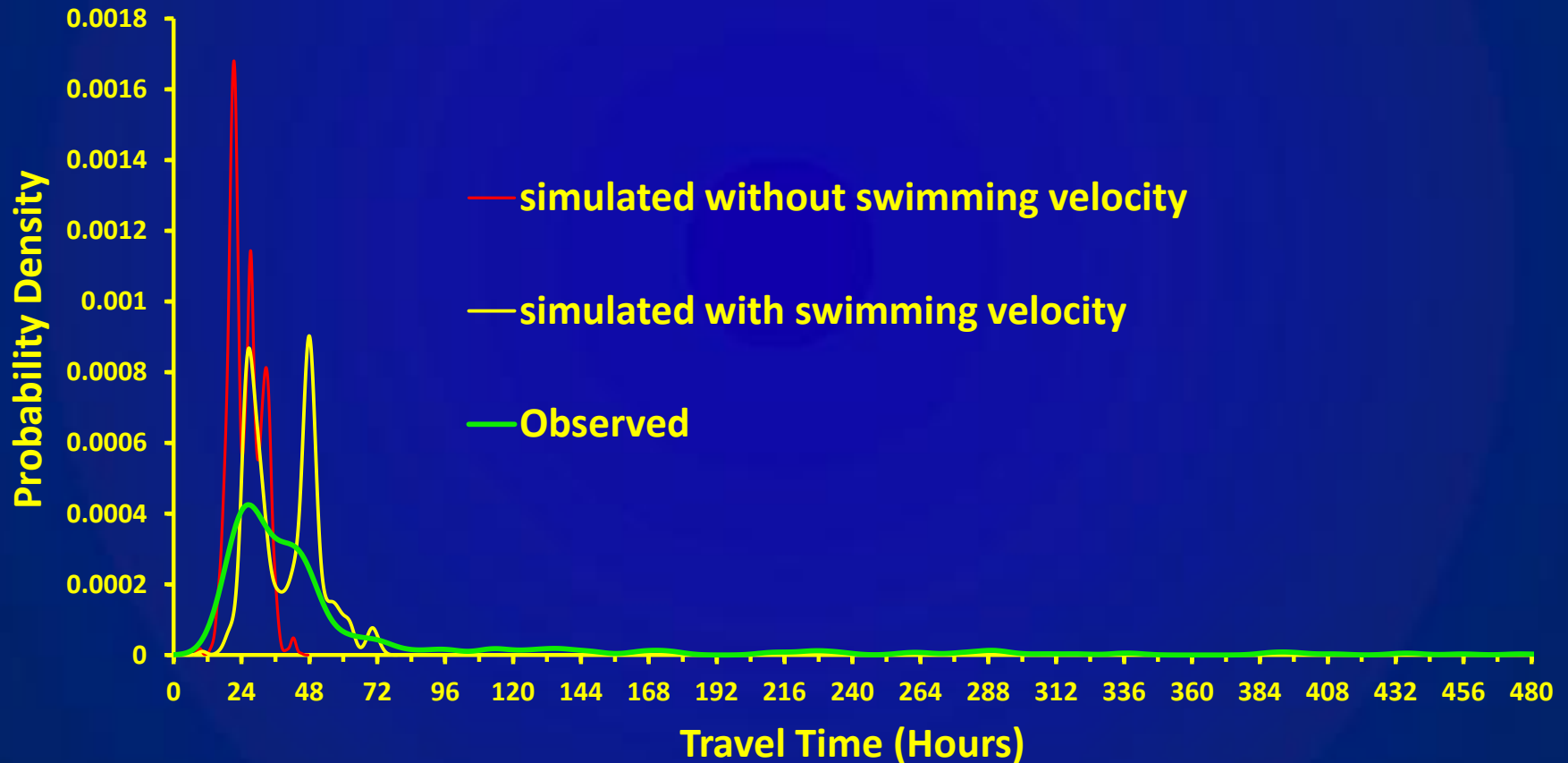
# Travel Time Distribution



# Travel Time Distribution

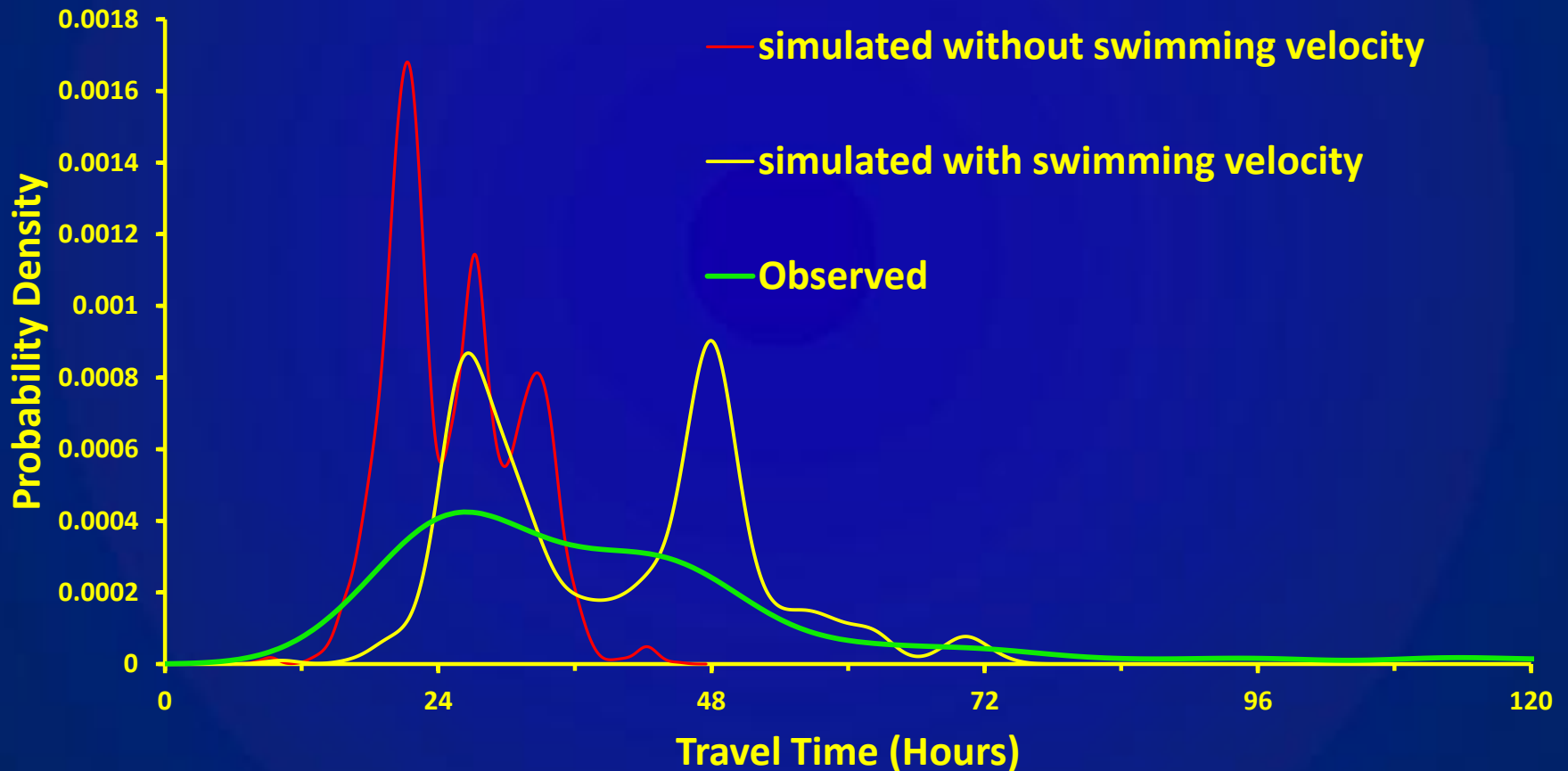


# Travel Time Distribution





# Travel Time Distribution



# Future Work: Statistical Analysis

- Swimming behaviors
  - Explore other parameters that affect travel time distribution, such as tidal/diurnal holding behavior
  - Incorporate more telemetry data sets
  - Estimate swimming velocities for other river reaches

# Future Work: Statistical Analysis

- Route and survival behaviors
  - Analyze multi-station/multi-year acoustic telemetry tag data
  - Develop routing models for route choice probabilities
  - Develop survival models for survival probabilities

# Future Work: PTM

- Implement behavioral models
- Modify PTM to take 3D velocities from a 3D flow model
- Build an open-source platform to facilitate collaborative model development

# Acknowledgement

## USGS:

- Russell Perry
- Jason Romine
- Adam Pope

## DWR:

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- Bob Pedlar
- Ryan Reeves

